GENERAL SYSTEMS ESSENTIALS: AN INTRODUCTORY COURSE FOR A MODERN GENERALIST CURRICULUM

Vincent Vesterby

ABSTRACT

General Systems Essentials is the introductory course for a curriculum leading to a doctoral degree in Modern Generalist Understanding. Because it presents general systems understanding that has been continued on from the work of Ludwig von Bertalanffy, it is also a course appropriate for anyone interested in systems science. It has been impossible to be a generalist in the traditional sense of quantity of knowledge. However, it is now possible to become a generalist in a new manner, based on quality and extent of understanding, which results in a discipline-independent form of knowing. Breadth and depth of understanding are achieved by using three universal, omnipresent aspects of all that exists as conceptual tools of exploration, analysis, understanding and description—General Factors, Structural Logic, and Development. The content of the course is presented in concise form as outline charts. Class time is for questions and discussion.

Keywords: systems curriculum; modern generalist; general systems; deep structure; realist philosophy

INTRODUCTION

For decades a multidisciplinary approach has been required by the complexity of large scale problems and projects. Because of persistent problems with cross-disciplinary communication, there has been a concurrent call for some way to achieve an overview capability for large scale issues. This call sometimes comes in the form of a request for a universal unification of knowledge [Wilson, 1999], or a generalist capability, a working knowledge of all the sciences—an apparent impossibility. For hundreds of years there has been no alternative to becoming a specialist. Now, however, due to developments in general systems understanding, a continuance from the work of Ludwig von Bertalanffy [Bertalanffy, 1968], it is possible to become a generalist—not in the traditional manner of quantity and extent of knowledge, but in a new manner, based on quality and extent of understanding.

General Systems Essentials is designed to serve as the introductory course for a Modern Generalist Curriculum leading to a doctoral degree in Modern Generalist Understanding. Because the course presents deep understanding of many factors of systems origins, structures, and processes, it is useful for anyone interested in studying systems science.

The modern generalist mode is possible because it is a discipline-independent mode based on three universal, omnipresent, aspects of the intrinsic nature of all that exists, three factors that play roles throughout all the disciplines.

- General factors.
- Structural logic.
- Development.

A general factor is anything that exists and plays a role in the intrinsic nature of reality in two to many different situations. General factors can be used as conceptual tools to obtain understanding of anything that exists. With any unfamiliar situation or system there will always be general factors present that can be used to obtain conceptual access to that situation or system.

Structural logic is the intrinsic logic of reality, the manner in which the intrinsic qualities of something that exists determine the types of relations that something can have with other things that exist. Used as a conceptual tool, structural logic enables the development of understanding of the interrelations between things [Vesterby, 2008b].

Development is the difference from one place, part, state, stage, or situation to another involving some form of enhancement. The enhancement can be as simple as increasing distance through space or the increasing quantity of time that is occurring, or it can be as complex as the consequences of biological evolution. Because development is the sequential order of relations between all that exists, through space and structure, through time and process, it can be used as a conceptual tool, providing understanding of the progression in structure and in process from what has gone before to what follows, from cause to effect, from parts to emergent wholes, from the simple to the complex.

These three exist as patterns of organization of space, time, and matter, and the modern generalist uses these patterns as conceptual tools of exploration, analysis, understanding, and description. Because general factors, structural logic, and development are factors of the intrinsic nature of reality, using them as conceptual tools matches the thinking within the mind to the reality referents of that which is thought about. Thinking in the mode of general factors, structural logic, and development, that is, thinking in the mode of their interrelating patterns of organization, specifically matches the qualities of the concepts within the mind to the qualities of the reality referents of those concepts, resulting in a high degree of objective understanding.

General factors, structural logic, and development are components of the modern generalist's intellectual toolkit. Three other components of the generalist toolkit, which are also presented in this introductory course, are of significant value to anyone studying systems science.

- Biological epistemology—The recognition that biological evolution has honed experiencing, knowing, and understanding to be effective tools to analyze, understand, and communicate diversity, change, and complexity.
- Realist philosophy—The recognition that systems are real, they exist throughout the universe, and therefore require a realist approach to create and/or work with them in an effective manner.

- The prime imperative of analysis—For the accurate analysis of the intrinsic nature of reality, of that which exists, look to reality itself, allowing the nature of reality to dictate the nature of the understanding of reality. Analyze the reality referents of concepts, rather than the concepts themselves.

These three components guide the use of the first three, and thereby further orient the mind to objective understanding. Practice with these six components greatly enhances the ability to analyze and understand the origins, structures, and processes of systems.

PRESENTATION OF COURSE CONTENT

In the course, this material, and what follows from it, is presented in the form of graphic outlines (Figure 1). A modern generalist needs to see as much of a situation as simultaneously as possible. Thinking in the mode of general factors, structural logic, and development is primarily pictorial, a dynamic mental imaging of interrelating patterns of organization. The most difficult task of a modern generalist is not discovering new knowledge. What is hard, and time consuming, is translating understanding from the multirelationality of three-dimensional space, matter, structure, motion, emergence, cause, and process into the linearity of language. On the printed page, the relations between the written concepts are further disguised by the block form of the paragraphs.

As a counter to this disguising of conceptual relations, a modern generalist always writes in outline form, reformatting to standard paragraphs only for secondary reasons such as preparing a manuscript for publication. The outline format visually aids the identification of conceptual relations, increases the rate of comprehension, and enhances the overview. These benefits are in large part due to the hierarchic arrangement of the sentences. A further benefit occurs because the added clarity helps keep the discussion focused, making it more concise.

The graphic outline was devised to take advantage of these benefits, and to add to them. One of the reasons a picture is worth a thousand words is because the visual aids in the picture—spatial relations, color, patterns of organization, the holistic view—do a great deal of work for the mind. The mind is left free to focus on significance, on meaning.

There are a variety of visual aids employed in this graphic outline:

1. Hierarchic organization.
2. Connecting lines.
3. Dendritic organization.
4. Box outline for each sentence or concept.
5. Line thickness.
6. Color.
7. Color shade.
8. Numbering.
9. Font color.

It is a second role of the connecting lines that makes the graphic outline not just hierarchic, but also dendritic. The graphic outline format, with its dendritic pattern, makes the overview accessible.

These graphic outlines are designed to be used on a computer—the larger the screen the better. Each graphic outline is created as a single vertical image, and it is possible to scroll up and down to see any part not showing on the monitor. They are best viewed on a monitor that can be turned to a vertical or portrait position. The reason it is best to view them on a large vertical screen is to allow a view of the entire graphic outline. This gives the overview or holistic view that provides as much information as possible as simultaneously as possible. It enables the eyes to quickly roam over the entire chart relating various parts one with another. You see the big picture and the details simultaneously.

There are Outline links that connect to additional graphic outlines, resulting in multiple pathways of investigation into deeper levels of details. These pathways of Outline links also have a dendritic organization of connections, similar to that of graphic outlines themselves. There are also Reference, Essay, and Illustration links connecting to supplementary material [Vesterby, 2008a].

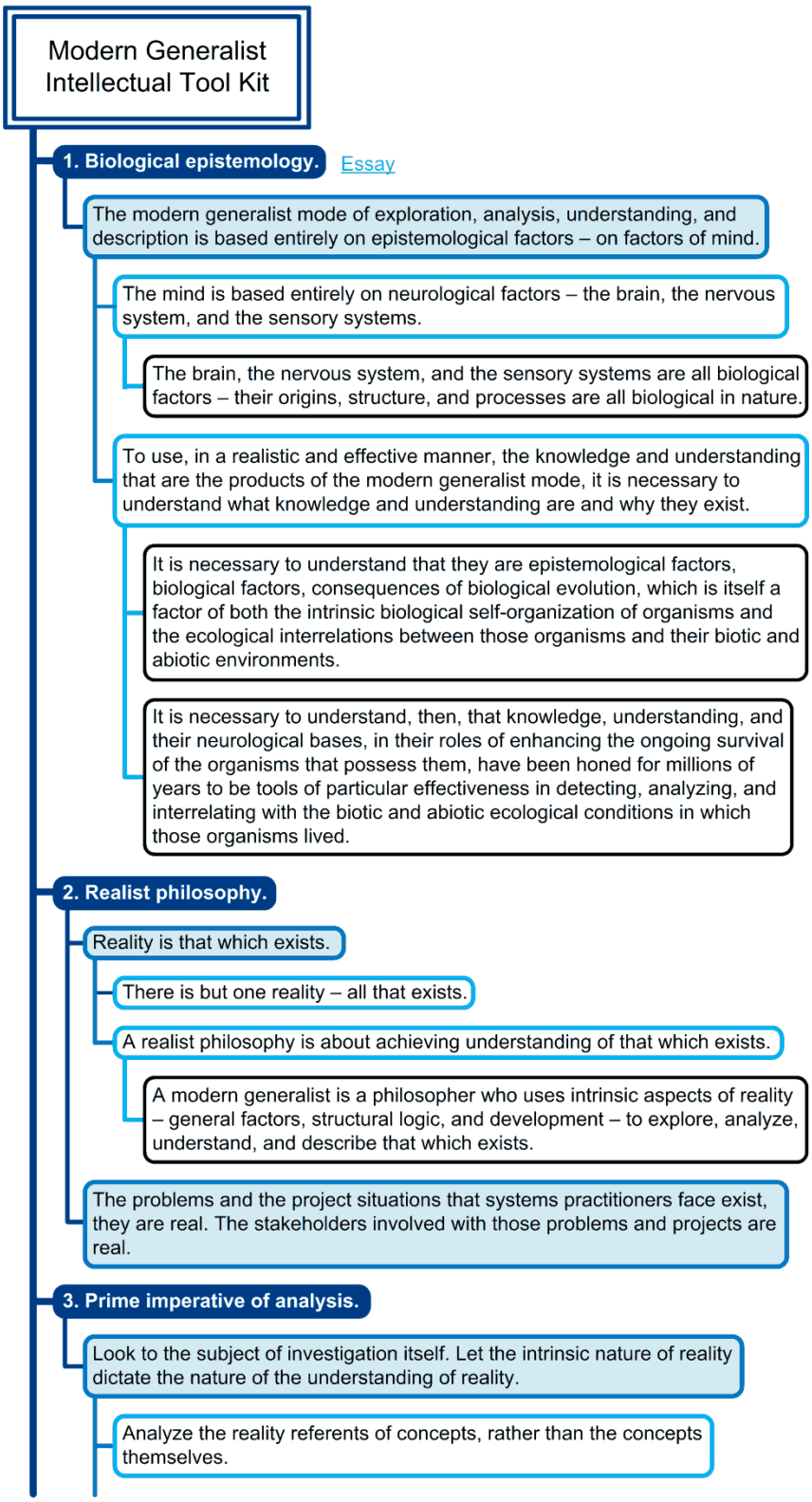


Figure 1. Modern generalist intellectual tool kit graphic outline.

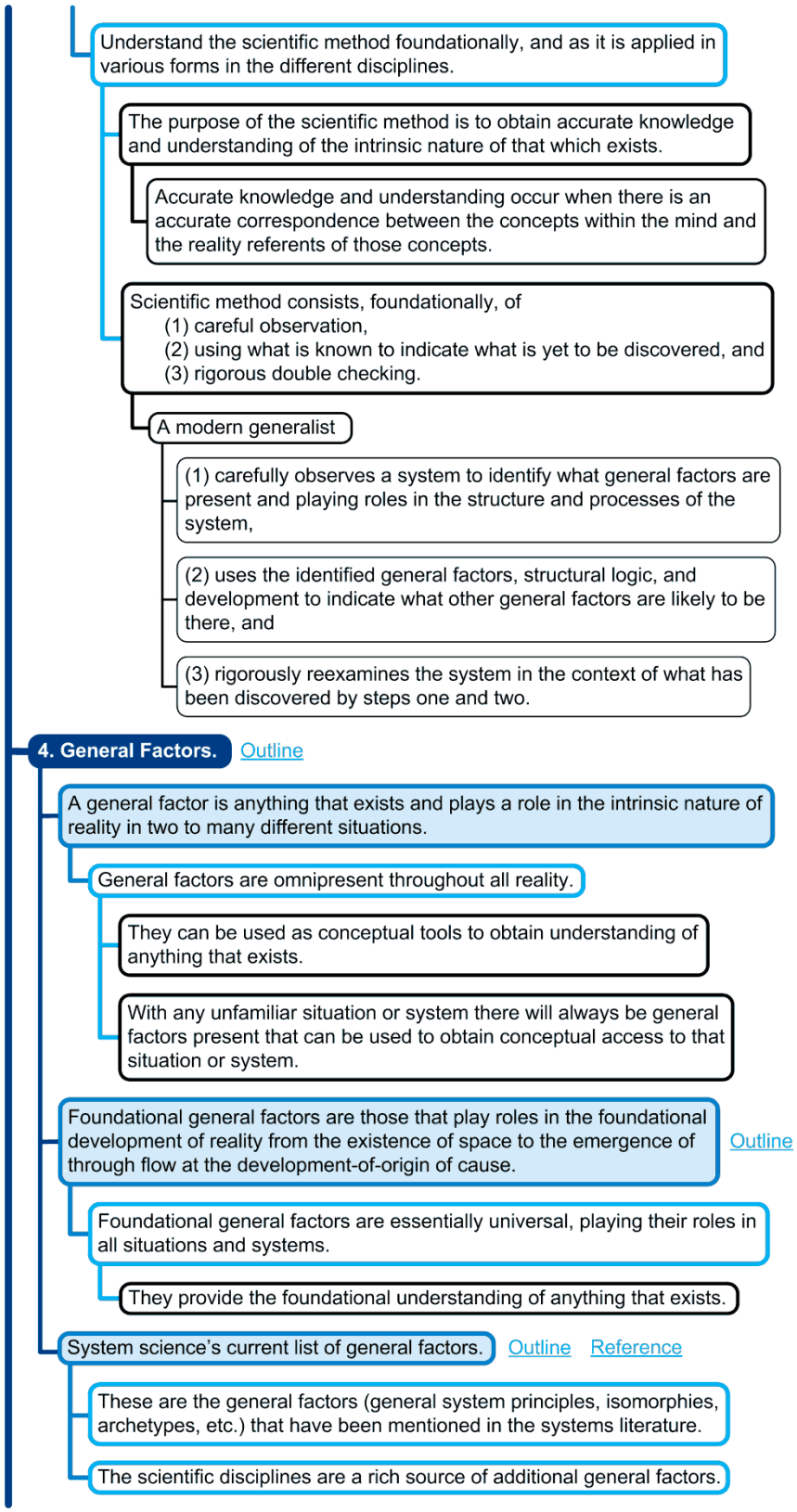
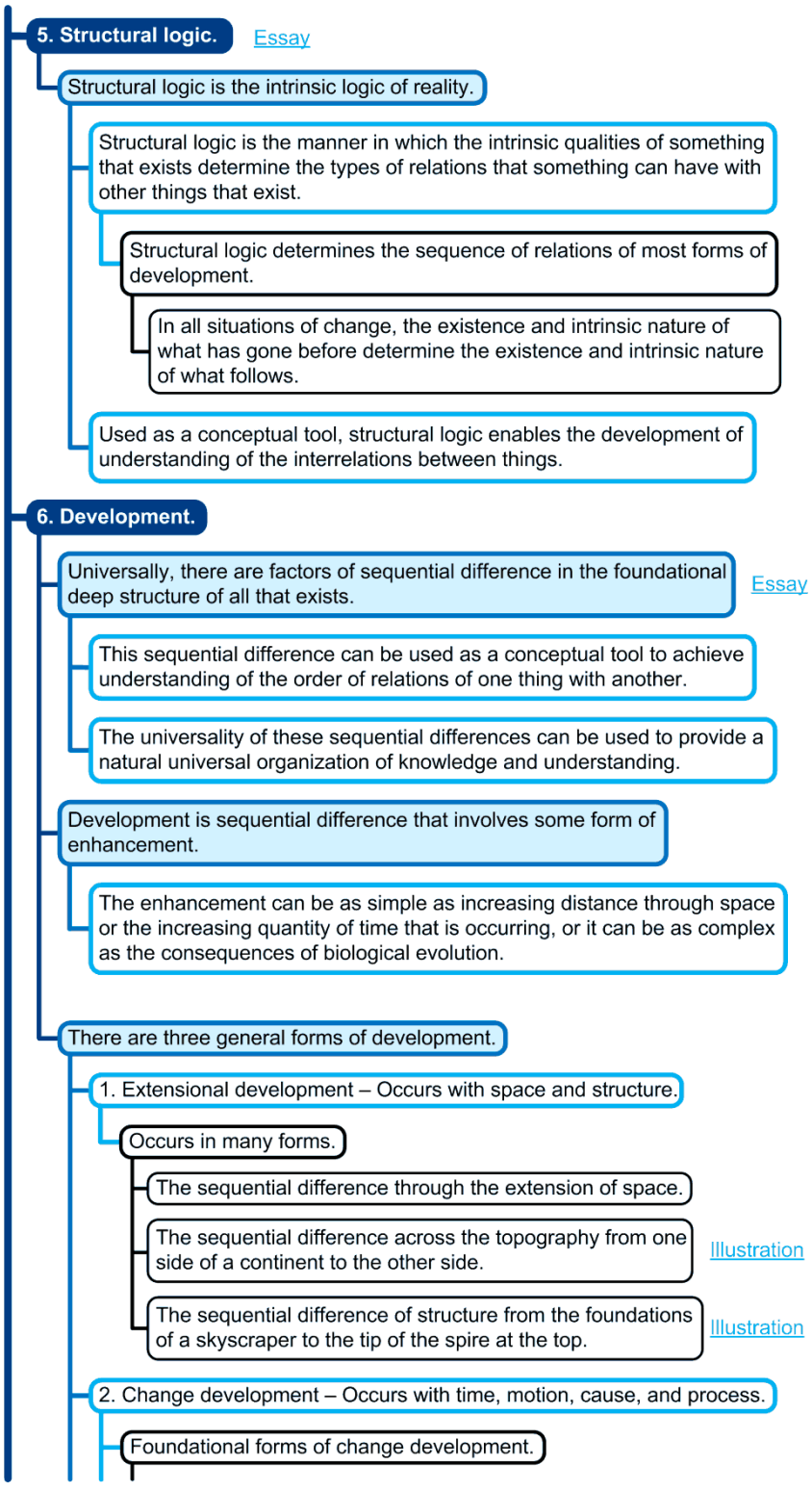


Figure 1. (continued)



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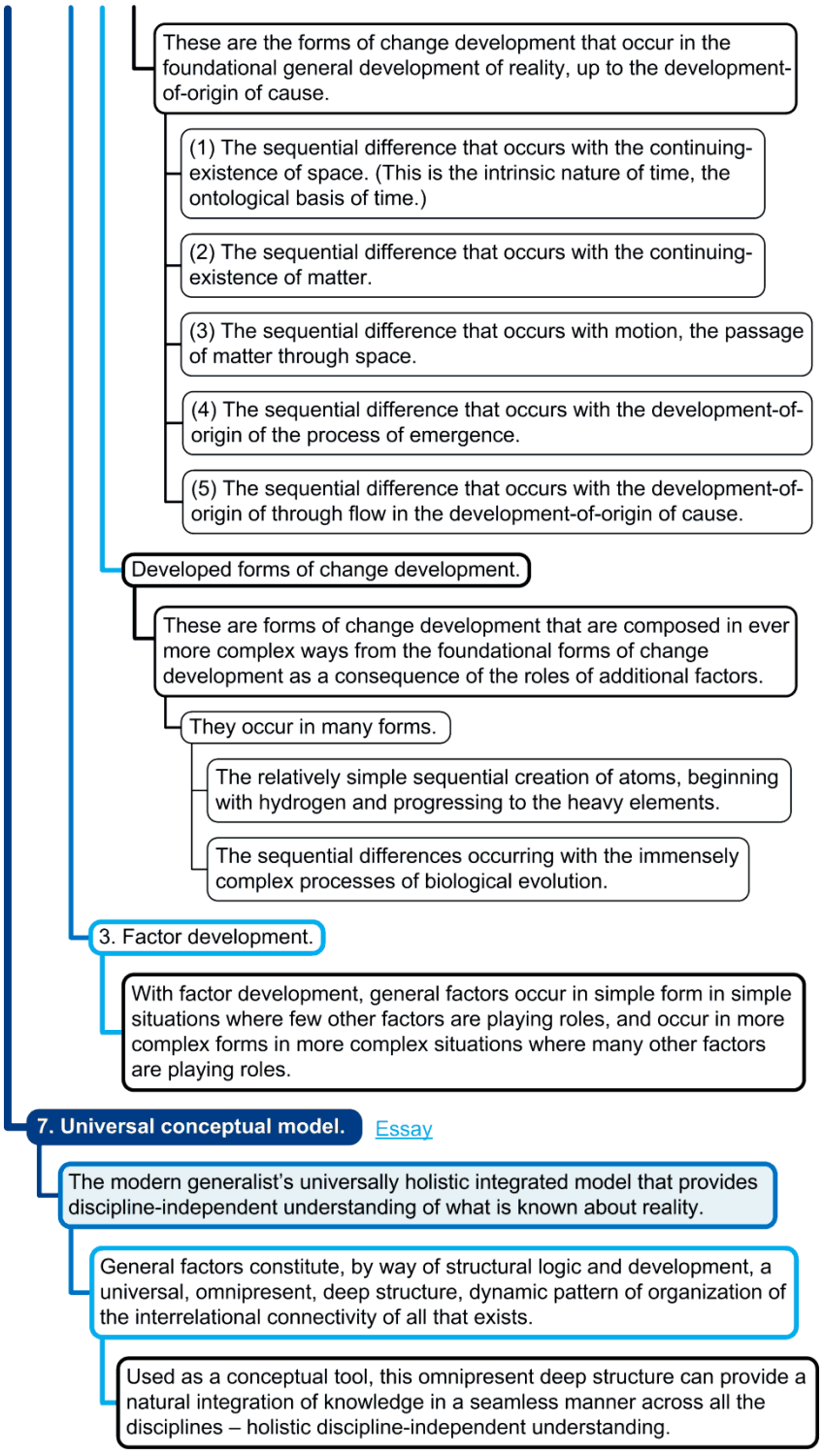


Figure 1. (continued)

At the beginning of Figure 1 there is a title box with two lines around it, and at the beginning of Figure 2 there is another title box, this one with four lines around it. These lines indicate the

hierarchic depth of the graphic outlines. Figure 1 is a second level chart and Figure 2 is at the fourth level. There is a graphic outline above *Modern Generalist Intellectual Tool Kit*, linking to it, and another graphic outline, at level three, between *Modern Generalist Intellectual Tool Kit* and *There Are Two Basic Forms of Factor Development*, linking up to the one and down to the other. In these examples the linkage is linear from the first level to the fourth level. But in the actual course material, each graphic outline will have multiple links down to lower level graphic outlines, resulting in the dendritic pattern of organization of the course syllabus.

In the introductory course General Systems Essentials, the graphic outlines are the primary study materials, with supplementary readings from the book *Origins of Self-Organization, Emergence and Cause*. There will be no formal lectures, class time being devoted to questions and discussion.

THE CURRICULUM LEADING TO A DOCTORAL DEGREE

There are two main areas of study in the curriculum, (1) general systems understanding, and (2) supplementary courses: foreign language, mathematics, expository writing, literature, and history.

With general systems understanding there are two introductory courses, General Systems Essentials, and if the university has one, an introductory survey course of the current state of systems science. This survey course introduces the student to systems practice and to the campus systems community.

The main course of study consists of guided independent study. The students will audit most of the science courses taught at their university. They would not do the assignments or take the tests. Instead they would mine the course material, the texts and the lectures, for general factors, learn to view the course material by way of structural logic and development, and as a term assignment they would compose a summary of the subject area of the science. They would write descriptions of the specific forms the general factors have in the subject area of each science. Additionally, the students would write a report discussing the integration of the subject area of the science with the subject areas of other interrelated sciences.

Each of the supplementary courses plays a supportive role for general systems understanding. One foreign language is required. This should be a major world language in which science is published and which is widely used in systems science. By graduation the students should have sufficient command in listening, speaking, reading, and writing in their foreign language to successfully attend a conference in that language.

Mathematics courses will be audited. The students will analyze the math itself, discovering precisely how and why mathematical relations work. The goal is to develop enough understanding of math to be able to find and discuss general factors occurring therein. This level of insight is expected to enable graduates to understand the use of math in the various disciplines.

This curriculum requires a great deal of rigorous expository writing. The vast majority of writing resulting from general systems understanding is purely descriptive in nature. For example, definitions of terms are based solely on descriptions of intrinsic significant aspects of

the reality referents of the terms. The students will be advised to take an expository writing class if their university offers one. Beyond what they learn in that class, their writing should reflect the modern generalist developmental habit of mind. The writing should describe things developmentally from the simple to the complex, from what goes before to what follows, from the lower levels to the higher levels. A challenging writing assignment each term will be the integration of the general factors the student has found in the audited classes into the student's progressively growing universal conceptual model.

General systems understanding at the level of a modern universal generalist requires a certain maturity of mind, a maturity of understanding. It is the opinion of this writer that that is not possible without exposure to great works of literature, such as that of Shakespeare and Tolstoy. The students should audit as large a diversity of history classes as possible. This also contributes to maturity of understanding. Additionally, students should look for the presence and roles of general factors at this very high level of dynamic change.

The students will learn:

1. To identify the development of a general factor from the level of elementary particles to the level of cosmology, or from the development-of-origin of the general factor to its most complex form.
2. To identify general factors in a system—what general factors are present in the system and what stages of factor development each one has within the system.
3. To identify roles of general factors in a system.
4. To demonstrate each stage in the development of a general factor in the lab or in the field by observing a case of each stage.
5. To identify the general factors that are present and playing roles at specific levels of organization of a system, such as at (a) the level of chemical interrelation of the metabolic system in cells, or (b) the social level of interrelations between the people of a corporation, or (c) the social level of competitive interrelations between the plants of an ecosystem.
6. To identify the consequences of the roles of general factors, both within the system of which it is a component and in the environment of the system.
7. To identify roles of prior forms of a general factor within more developed forms of that factor.
8. To map emergence as with (a) the emergence of levels one from another, (b) the emergence of whole systems from their components, and (c) the emergence of the subject areas of the higher level sciences from the subjects areas of the lower level sciences.
9. To use a discipline-independent form of knowing and understanding by integrating all identified general factors, their developments, and their interrelations into a single, coherent, comprehensive body of knowledge and understanding—the synthesis of general systems understanding—the modern generalist universal conceptual model.

Because the course, and the curriculum, are completely transdisciplinary, they should be independent of any particular discipline, whether science, business, or the humanities, and be

hosted by the university itself. Alternatively, because general systems understanding is rigorously based on science, the course and curriculum could be hosted by the division, faculty, or college of science. One other possibility would be for an institute for advanced study to be the home for this course of studies.

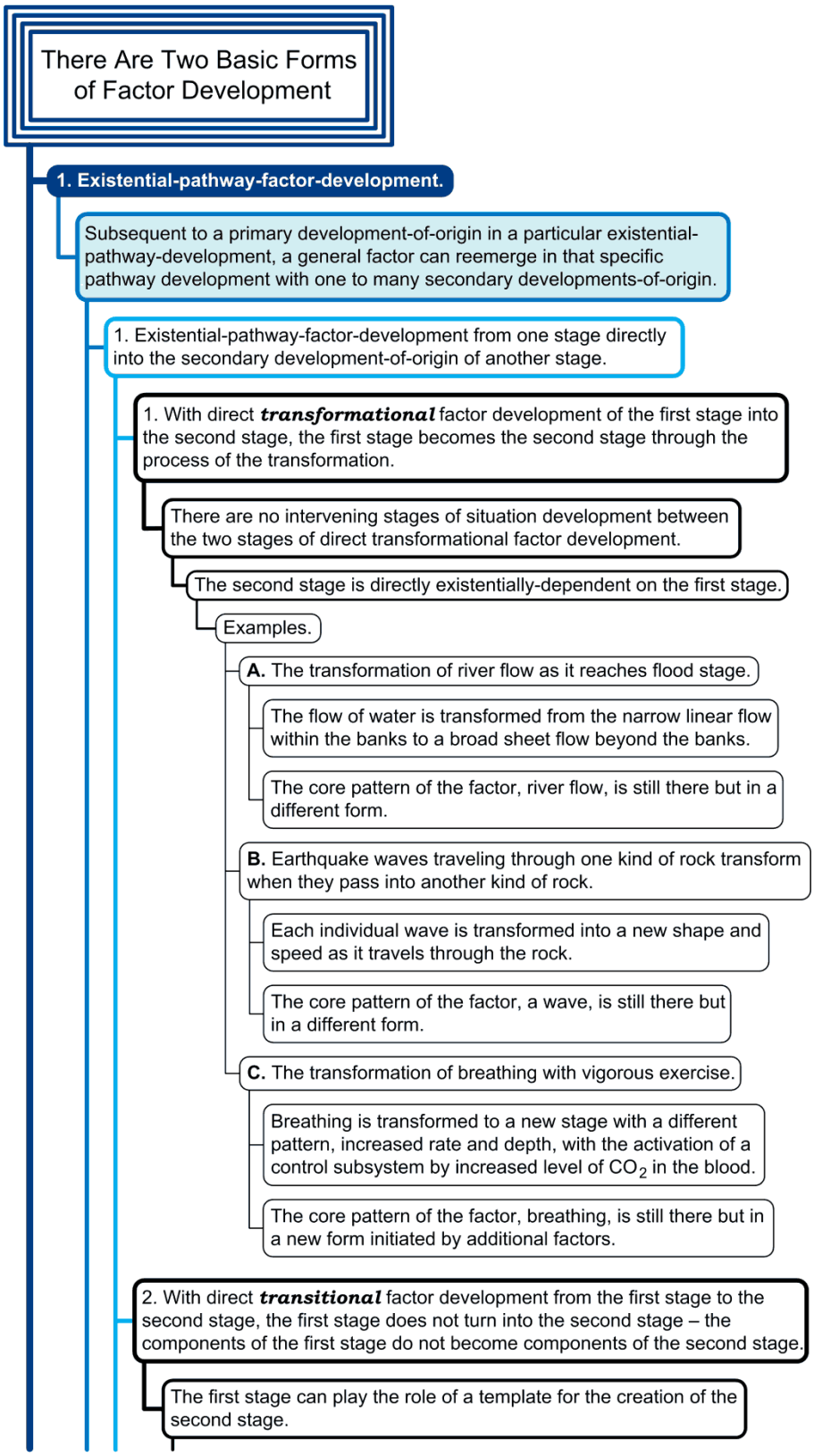
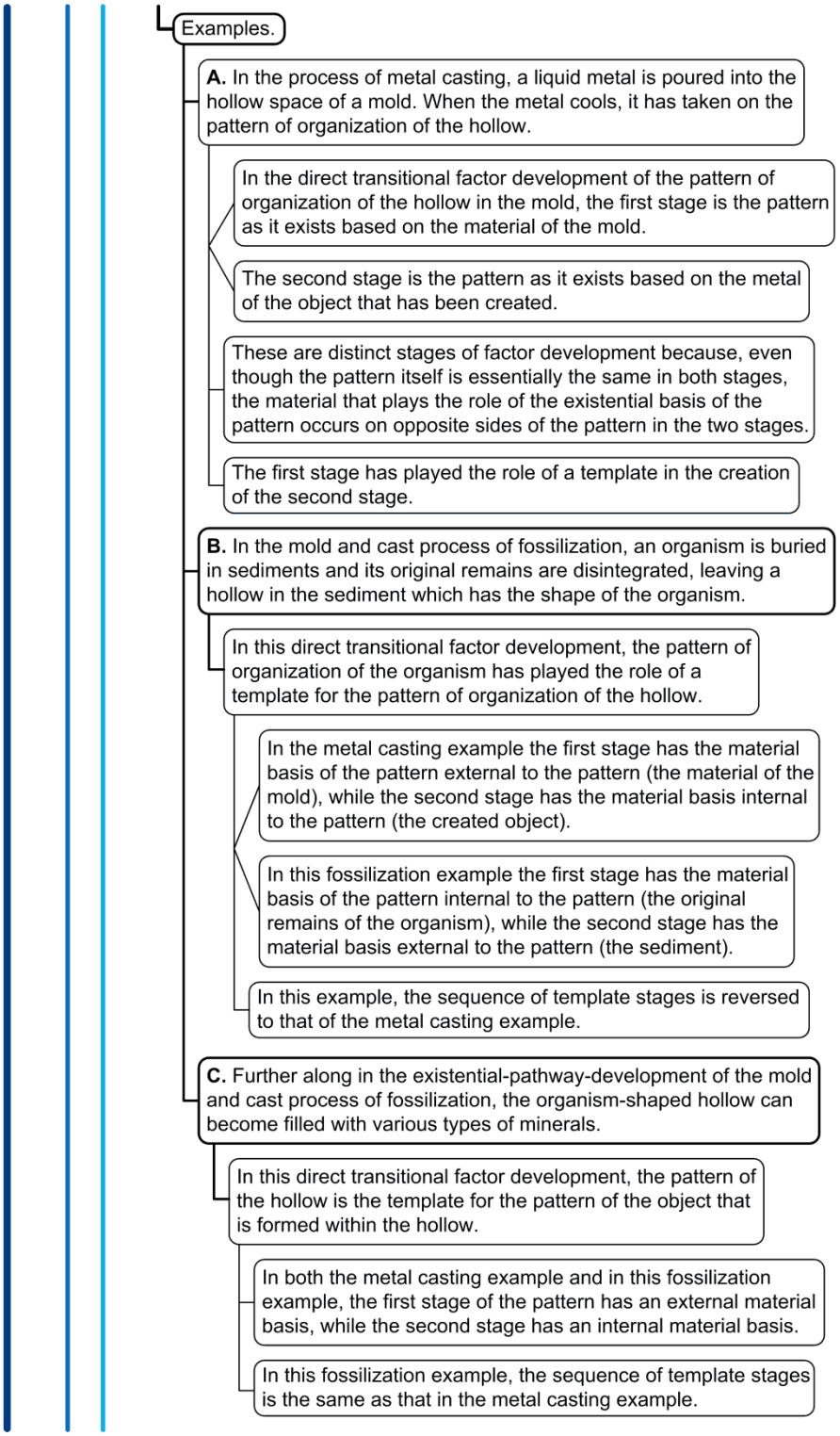


Figure 2. There are two basic forms of factor development.



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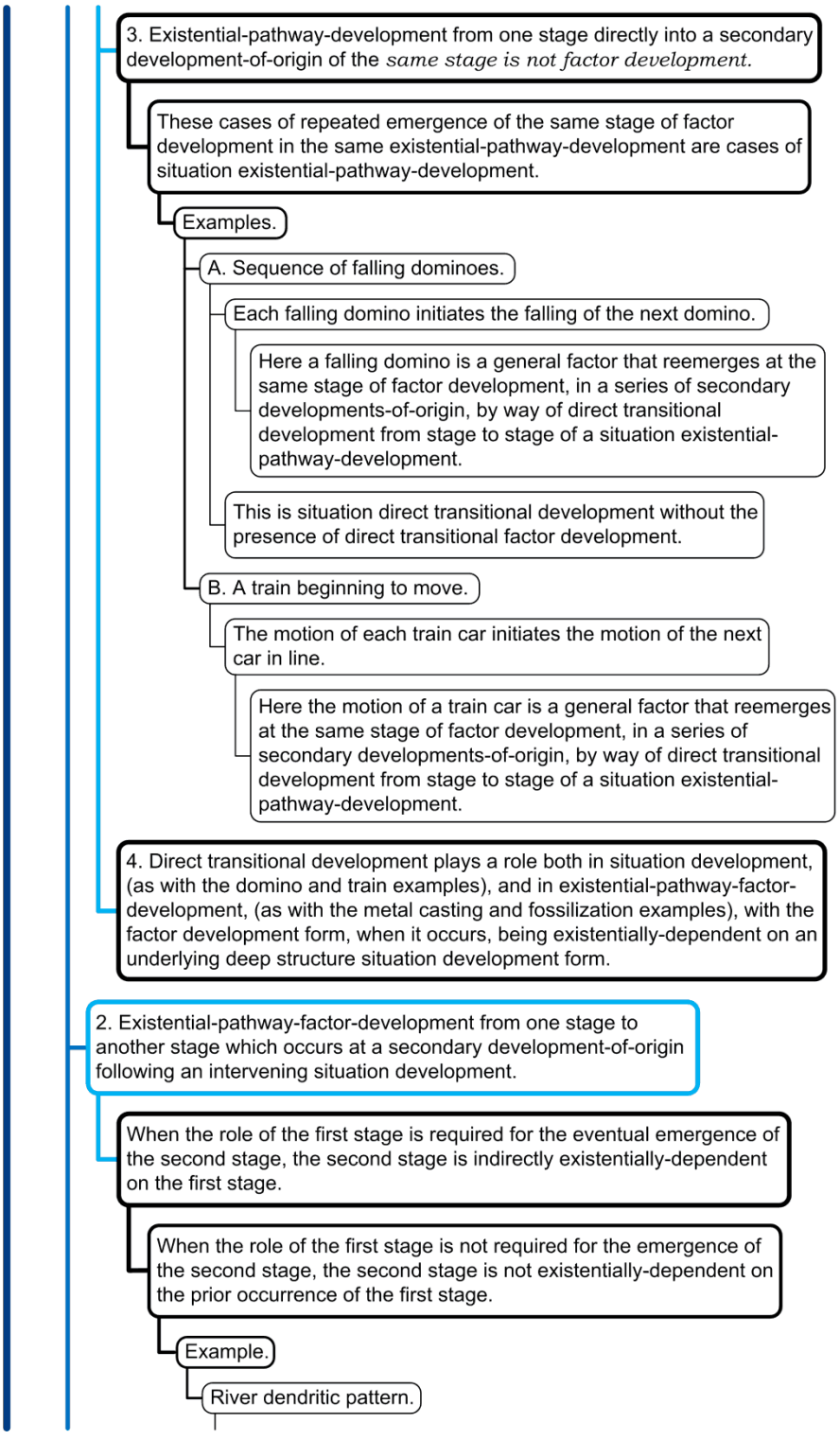

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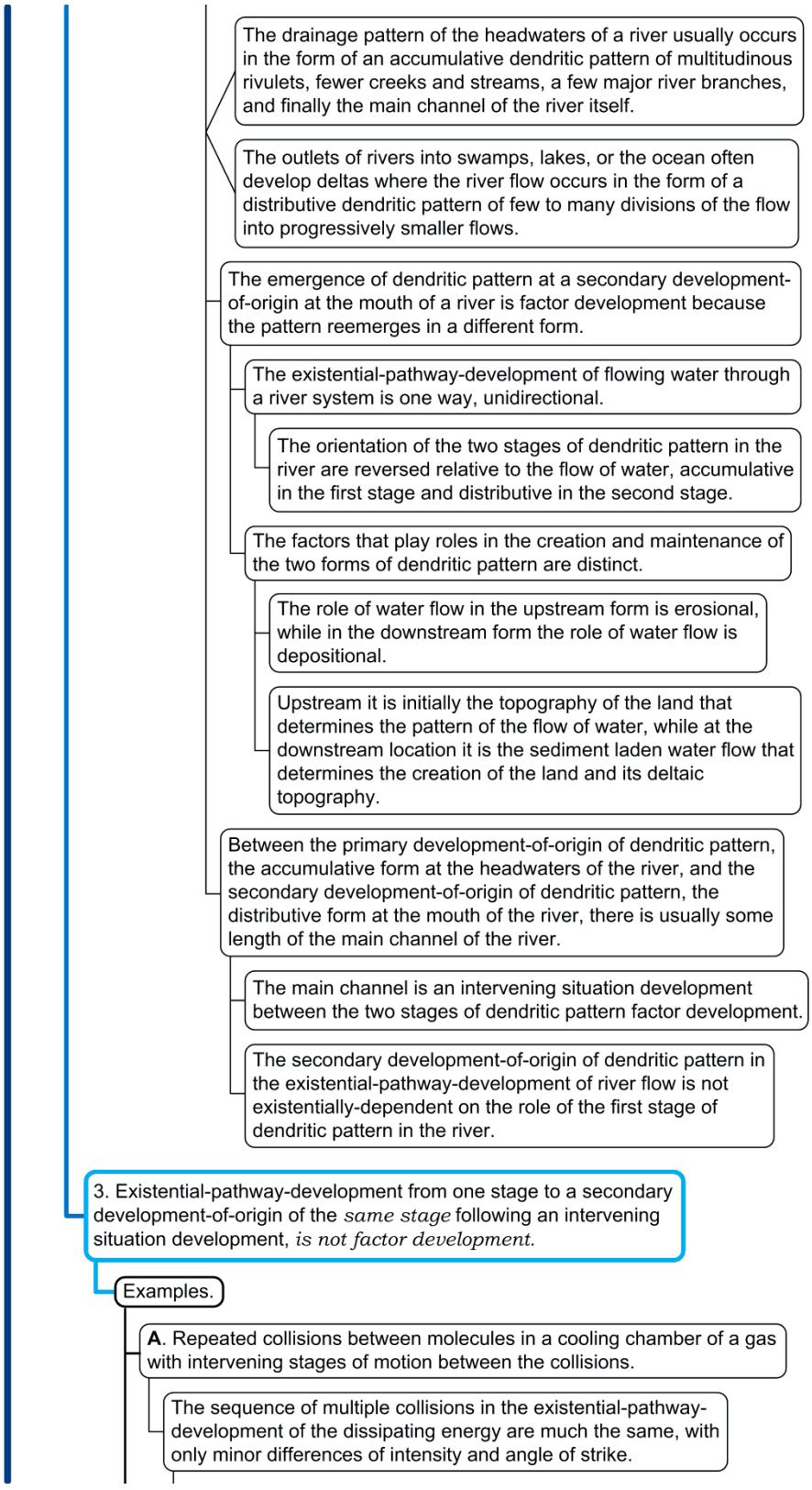

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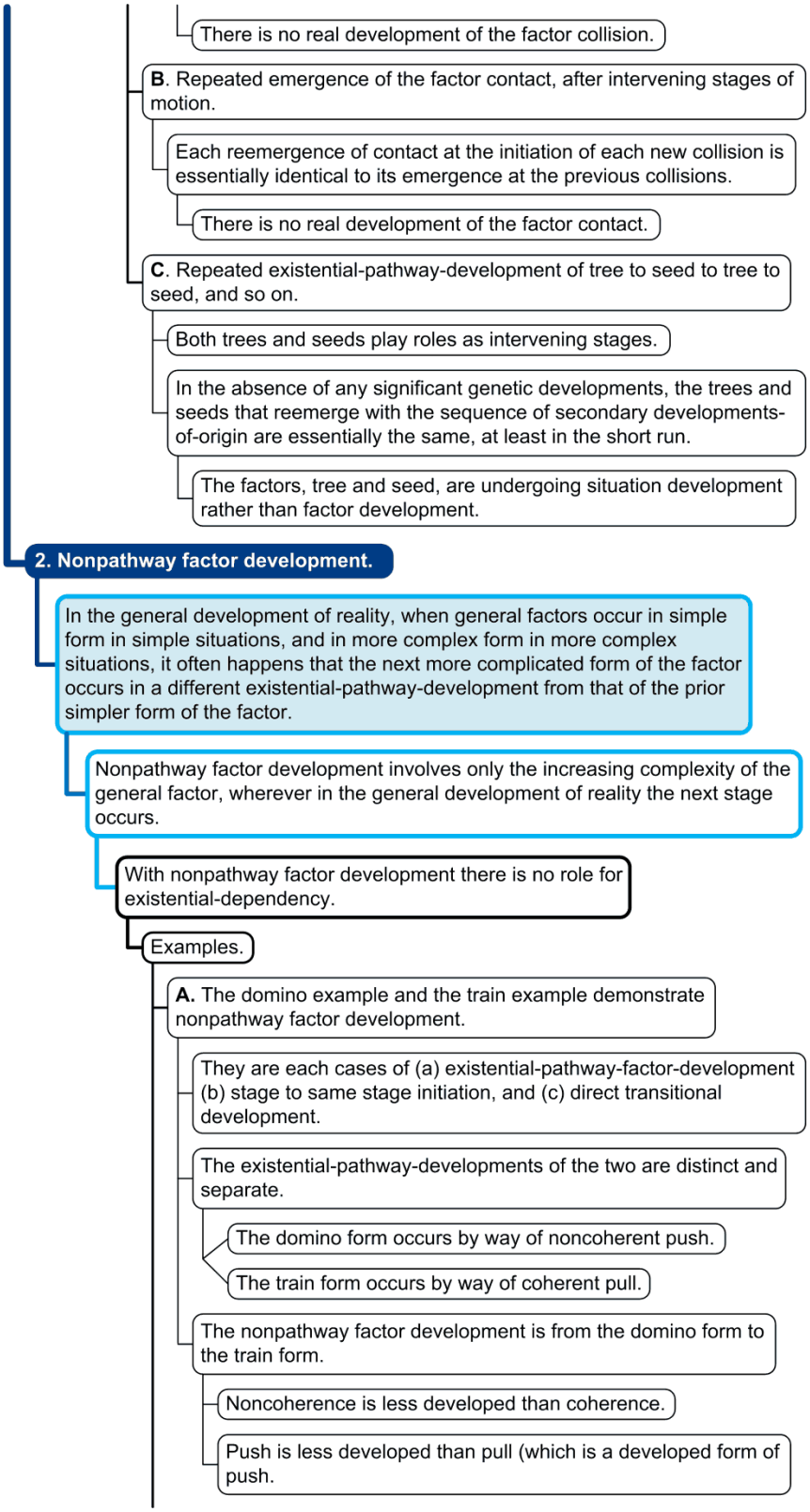

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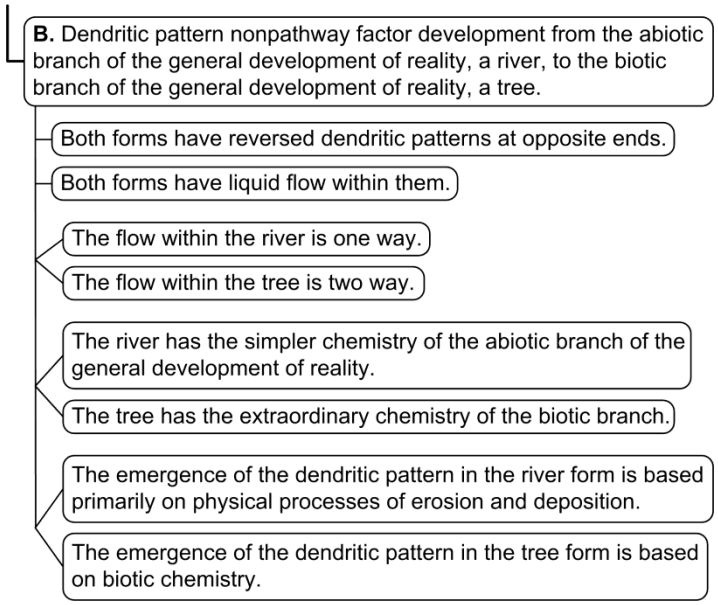

Figure 2. (continued)

BENEFITS

The modern generalist mode can be used to understand systems in any discipline. It enhances the ability to identify general patterns at various levels and in different disciplines through understanding the deep-structure of such patterns. With factor development, general factors occur in simple form in simple situations, and in more complex forms in more complex situations. No matter how complicated a developed form may be, the pattern of organization of the basic form is still there, giving the developed form its identity as a case of that particular general factor. Thus, understanding the basic pattern enhances recognition of more complex forms at whatever level they may occur or in whatever discipline. Searching out higher level developed forms of simpler general factors instills the habit of mind to see things and relations as patterns of organization. The mind soon begins to notice the patterns of organization of general factors as common features of systems in various disciplines and at multiple levels.

The generalist way of looking at things displays the interconnectedness between and within all the levels through the use of the general factors that play roles of connectivity between and within the subjects studied by the various disciplines. Everything that exists is connected to something else that exists. Through continuing-existence that which has gone before is connected to that which follows. Through emergence higher levels develop from the interrelations of lower levels. Material structure emerges by way of contact and coherence. Process emerges by way of motion and cause. These pathways of connection through space and structure, through time and process, provide pathways of understanding. Understanding these pathways of connection establishes conceptual coherence.

This way of looking at systems makes it possible to understand change within individual systems, and between systems, through the use of the general factors that constitute the basis of

all forms of change. Change originates in simple forms such as continuing-existence, motion, emergence, cause, and accumulation. Developmentally prior forms of change, such as continuing-existence, motion, and emergence, play necessary roles in the nature of more developed forms of change, such as cause and accumulation. In general, the simpler forms of change together constitute the deep-structure core of well developed forms of change, such as growth, ontogeny, evolution, ecological succession, and social development. The consequence of this role of the simpler core factors is that in all forms of change the existence and intrinsic nature of what goes before determines the existence and intrinsic nature of what follows. Change general factors, structure general factors, and structural logic together determine the consequences of all forms and cases of change, thus providing the conceptual tools needed to analyze change in various types of systems. These understandings form the core of what Ian Stewart was looking for when he wrote, "More generally, we can hope to see the beginnings of a qualitative, contextual theory of dynamic pattern formation" [Stewart, 2002].

The generalist mode enables critical reasoning at multiple levels through the use of the structural logic inherent in general factors and their interrelations. Structural logic is the manner in which the intrinsic qualities of a general factor determine the kinds of relations that general factor can have with other things that exist. Structural logic, as a conceptual tool, is a method of reasoning about the nature of systems that is derived from the intrinsic nature of systems themselves. General factors provide the organization of structure and process of the systems in which they occur. General factors, as conceptual tools, provide a way for the mind to enter into a situation or system and make sense of the particulars and their interrelations. System dynamics does this by recognizing archetypes in complex situations [Maani and Cavana, 2007; Senge, 1990; Sterman, 2000]. Suddenly something is known about a situation, something about its pattern of organization and how it functions. Thinking in the mode of general factors allows the intrinsic structural logic of general factors to dictate the use of that logic to understand systems at multiple levels.

Using the conceptual tools of a modern generalist enables the integration of multidiscipline knowledge through the use of the general factor development, the universal general factor of connectivity. Everything that exists is developmentally connected by way of structural logic to something else that exists. Development establishes the interrelated order of all other factors. As a conceptual tool, development establishes the interrelated order of all knowledge.

The modern generalist mode enables general holistic understanding through the use of those general factors that provide unity, depth, and breadth of understanding. Unity through developmental factors of connectivity, such as structural logic, emergence, cause, coherence, and process. Depth through general factors of hierarchic organization, factor development, and system deep structure. Breadth through the universality of many general factors. General holistic understanding is achieved by way of general factors that provide understanding of the seamless developmental connectivity of the structural logic of the emergence of one level from another—as in the emergence of the subject areas of the higher disciplines from the subject areas of the lower disciplines. This general holistic understanding develops into the modern generalist's universal conceptual model [Vesterby, 2007].

The generalist way of thinking provides discipline-independent understanding through the use of general factors whose core patterns of organization are independent of level of organization. Well developed stages and higher level forms of a general factor are usually

different in various ways from the basic form at its first stage and lowest level. Nonetheless, that basic form of a general factor is still there as the core pattern at developed stages and higher levels. The particulars of the various disciplines are not required to understand the core patterns of organization of general factors. The patterns of organization of general factors can be understood independently of any discipline. Understanding core patterns of general factors, plus factor development, in combination with general holistic understanding results in discipline-independent understanding—the modern generalist mode of understanding.

FURTHER CONSIDERATIONS

This paper was originally presented at the International Society for the Systems Sciences 2010 Conference at Waterloo, Canada. Subsequent discussions brought out some significant questions and issues.

Clarification of what being a generalist means

There are two major types of generalist in the modern world, the discipline generalist and the universal generalist. Basically they differ in the epistemological methods they use and in extent and type of knowledge. The distinction blurs somewhat when a discipline generalist adopts some of the methods used by a universal generalist. But the distinction in extent of knowledge always holds because the methods of the discipline generalist can include at most only a few disciplines, while the methods of the universal generalist extend throughout all the disciplines.

A discipline generalist achieves particularly extensive knowledge and understanding within a particular discipline, for example a systems science generalist, or a general practitioner in medicine. The primary method involves memorization of what is known within the field, the achievement of understanding of that knowledge, and the development of a facility in using that knowledge and understanding.

A universal generalist, a modern generalist, achieves particularly extensive knowledge and understanding of (1) universal omnipresent factors that play roles in the origins, structures, and processes of all that exists, (2) factors of origins, structures, and processes that, while not universally omnipresent, are extremely common throughout the universe, and (3) many other factors of even less generality, but that still do play roles in diverse situations and multiple levels of the hierarchy of material reality. A modern generalist then develops a facility in the use of these general factors as conceptual tools for exploration, analysis, understanding, and description.

Two questions

In the discussion immediately following the presentation, one person in the audience asked about the relation between modern generalists and specialists, and then another person asked the closely related question about where a modern generalist will work.

A modern generalist is a scientific philosopher. As such, the generalist depends on the work of the specialists in all the various disciplines of science. Specialists are the primary source of the knowledge base of the modern generalist mode of exploration, analysis, understanding, and description. Without specialists there can be no generalists.

In turn, the modern universal generalist gives back to the specialists improved methods for interdisciplinary conceptualization, understanding, and communication. The modern generalist does this by identifying and describing the presence, the roles, and the developmental differences of general factors at the various levels of the hierarchy of material reality. This process identifies the presence of general factors in the subject matter of the various sciences that study those levels. The descriptions of these factors then provide bridges between the disciplines in the form of common knowledge and common language concerning those general factors which are common to various disciplines.

Another service the universal generalist can provide is the overview of complex situations and complex projects. A modern generalist has the habit of mind to conceptually travel broadly, across any and all boundaries, to examine what is to be found there, and to compare that with what has been found before. The result is a mental map of the territory covered, which can be as broad and as detailed as called for. As a member of a complex project team, the universal generalist brings together all the details of all the specialists into a single unified conceptual understanding. The generalist's unified conceptual model of a multidisciplinary complex project is a tool well suited for recognizing inconsistencies and omissions.

Another service the universal generalist can provide is a rigorous scientific base for systems science. Basing higher level systems knowledge and understanding on deep structure knowledge and understanding gives system science solid foundations.

A modern generalist can thus provide services in at least three ways:

- Improved communication and understanding among the disciplines.
- Overview of complex projects and systems.
- A deep scientific foundation for systems science.

Where, then, will modern generalists work? When conducting the research that will improve communication among the disciplines and that will give systems science a solid scientific foundation, modern generalists are likely to work for research institutions. Examples would be universities, or think tanks and research institutes where the target of the research requires input from diverse disciplines.

When providing overview, modern generalists would most likely work for governments and non-government organizations that face or manage highly complex issues and problems such as

disarmament, world peace, population control, wildfire management, world fisheries management, human rights, national health care systems, national economies, management of large national parks and reserves, environmental degradation and global warming, management of state and national forests, and designing and managing the built environment.

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